

CLAIMS:

What is claimed is:

1. A device controller for coupling one or more controlled
5 devices to one or more processors in a processing system,
comprising:
 - a command unit for sending commands to said one or more
devices;
 - at least one usage evaluator having an input coupled to an
10 output of said command unit for evaluating a frequency of use of
an associated controlled device; and
 - control logic coupled to said usage evaluator and further
coupled to an input of said command unit for sending power
management commands in response to said usage evaluator detecting
15 that a usage level of said associated device has fallen below a
threshold level, whereby said device controller power manages
said controlled device without intervention by said one or more
processors.
- 20 2. The device controller of Claim 1, further comprising:
 - an output port coupled to said at least one usage evaluator
for reading a state of said at least one usage evaluator, whereby
a state of said at least one usage evaluator may be stored
external to said device controller; and
 - 25 an input port coupled to said at least one usage evaluator
for setting a state of said at least one usage evaluator, whereby
said state of said at least one usage evaluator may be restored
from information stored external to said device controller.
- 30 3. The device controller of Claim 1, wherein said device
controller is a memory controller, and wherein said controlled
devices are memory modules.

4. The device controller of Claim 3, wherein said at least one usage evaluator comprises an inter-arrival time counter for determining an interval between accesses to said associated memory module.

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5. The device controller of Claim 1, further comprising one or more power management control registers, each associated with a particular one of said one or more controlled devices, each coupled to an input port of said device controller and further
10 coupled to said command unit, whereby a power management control state for said associated controlled device can be set by said one or more processors and set in said associated controlled device by said device controller.

15 6. The device controller of Claim 5, wherein said power management control registers are further coupled to said at least one usage evaluator, whereby values of said power management control registers are adjusted in conformity with a result of said evaluating.

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7. The device controller of Claim 1, wherein said evaluator further comprises an adaptive threshold circuit for adjusting said threshold in response to said evaluated frequency of use of said one or more controlled devices.

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8. The device controller of Claim 1, wherein said one or more controlled devices include a counter for determining a level of usage of each controlled device during a current process, and wherein said device controller further comprises an input port
30 coupled to each of said controlled devices for reading a value of said counter, and wherein said control logic updates said at associated evaluator in conformity with said value of said counter.

9. The device controller of Claim 6, wherein
said device controller is a memory controller, wherein said
controlled devices are memory modules incorporating usage
counters, and wherein said control logic is coupled to said
5 command logic whereby said control logic periodically reads
current counts from said memory modules.

10. A processing system, comprising: ✓

a processor;

a memory coupled to said processor for storing program instructions and data values;

5 a device controller coupled to said processor;

one or more controlled devices coupled to said device controller, wherein said controlled devices have multiple power management states, and wherein said device controller includes a command unit for sending commands to said one or more devices, at least one usage evaluator having an input coupled to an output of said command unit for evaluating a frequency of use of an associated controlled device, and control logic coupled to said usage evaluator and further coupled to an input of said command unit for sending power management commands in response to said usage evaluator detecting that a usage level of said associated device has fallen below a threshold level, whereby said device controller power manages said controlled device without intervention by said processor.

20 11. The processing system of Claim 10, wherein said device controller is a memory controller, and wherein said controlled devices are memory modules.

12. The processing system of Claim 10, wherein said device controller further comprises:

an output port coupled to said at least one usage evaluator for reading a state of said at least one usage evaluator by said processor, whereby a state of said at least one usage evaluator may be stored in said memory by said processor; and

30 an input port coupled to said at least one usage evaluator for setting a state of said at least one usage evaluator by said processor, whereby said state of said at least one usage evaluator may be restored from said memory.

13. The processing system of Claim 10, wherein said at least one usage evaluator comprises an inter-arrival time counter for determining an interval between commands sent to said associated controlled device.

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14. The processing system of Claim 10, wherein said device controller further comprises one or more power management control registers, each associated with a particular one of said one or more controlled devices, each coupled to an input port of said
10 device controller and further coupled to said command unit, whereby a power management control state for said associated controlled device can be set by said processor and set in said associated controlled device by said device controller.

15. A method of managing power in a processing system,
comprising:

sending power management setting information for devices
controlled by a device controller to said device controller;

5 evaluating a usage of each of said controller devices within
said device controller in order to determine whether or not said
usage has fallen below a threshold; and

sending power management commands from said device
controller to said controlled devices in conformity with a result
10 of said determining, whereby said device controller manages a
power management state of said controlled devices without
processor intervention.

16. The method of Claim 15, further comprising:

15 receiving an indication of a context switch activating a
second process and deactivating a first process; and

in response to said receiving, saving a state of said
evaluating, whereby said state may be restored at a subsequent
context switch.

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17. The method of Claim 16, further comprising:

second receiving a second indication of a second context
switch reactivating said first process;

in response to said second receiving, restoring said saved
25 state of said evaluating, whereby said evaluating commences from
the previously stored state.

18. The method of Claim 15, further comprising retrieving usage
counts from said controlled devices, and wherein said evaluating
30 is performed in conformity with said retrieved usage counts.

19. The method of Claim 15, further comprising adjusting said threshold in accordance with a result of said evaluating, whereby said evaluating is made adaptive to said usage.

- 5 20. The method of Claim 15, wherein said device controller is a memory controller, wherein said controlled devices are memory modules, wherein said sending sends power management setting information to said memory modules, and wherein said evaluating determines a frequency of accesses to said memory modules.